

## Diversity and Population of Thrips Species on Legumes with Special Reference to *Megalurothrips usitatus*

(Kepelbagaian dan Populasi Spesies Jengking Daun pada Kekacang dengan  
Rujukan Khusus kepada *Megalurothrips usitatus*)

Z. ZAFIRAH\* & A.A. AZIDAH

### ABSTRACT

*Thrips* (Thysanoptera) are common pests on legume plants, yet little is known about their ecology or diversity in Peninsular Malaysia. In legumes, thrips are typically found in flowers, where their feeding activity causes malformations that eventually lead to crop damage. In this study, we examined the diversity of thrips species, particularly *Megalurothrips usitatus*, in three selected legume farms around Peninsular Malaysia (Janda Baik, Pahang; Bestari Jaya, Selangor; and Jelebu, Negeri Sembilan). Each month from April 2013 to May 2014, depending on growing season, legume flowers were inspected for thrips in five random plots from each farm. Sampling was performed six times in Bestari Jaya and Jelebu and twelve times in Janda Baik. The most abundant thrips species on legumes was *M. usitatus* (89.97%) followed by *Thrips parvispinus* (9.77%), *T. hawaiiensis* (0.13%) and *Ceratothripoides brunneus* (0.12%). The abundance of *M. usitatus* was not different between long bean, French bean and winged bean which equally distributed among different arbitrary strata on legume plants. Temperature and light intensity were found to be positively correlated with the abundance of *M. usitatus*, but relative humidity showed a negative relationship. *M. usitatus* was found in large numbers during hot and dry months, but in lower numbers during raining season. This study suggested that wet season may help to regulate the populations of *M. usitatus* on legume plants.

**Keywords:** Diversity; ecology; legume; *Megalurothrips usitatus*; thrips

### ABSTRAK

Jengking daun (Thysanoptera) adalah perosak yang biasa ditemui pada tumbuhan kekacang, namun sedikit yang diketahui tentang ekologi atau kepelbagaian mereka di Semenanjung Malaysia. Pada tumbuhan kekacang, jengking daun kebiasaannya dijumpai di dalam bunga dengan aktiviti pemakanan mereka menyebabkan kecacatan dan kerosakan pada tanaman. Dalam kajian ini, kepelbagaian spesies jengking daun, terutamanya *Megalurothrips usitatus*, di tiga ladang kekacang terpilih sekitar Semenanjung Malaysia (Janda Baik, Pahang; Bestari Jaya, Selangor; dan Jelebu, Negeri Sembilan) telah dikaji. Bergantung kepada musim tanaman, jengking daun disampel daripada bunga kekacang secara rawak setiap bulan daripada lima plot di setiap ladang dari April 2013 hingga Mei 2014. Spesies thrips yang paling banyak ditemui pada kekacang adalah *M. usitatus* (89.97%) diikuti oleh *Thrips parvispinus* (9.77%), *T. hawaiiensis* (0.13%) dan *Ceratothripoides brunneus* (0.12%). Kelimpahan *M. usitatus* pada kacang panjang, kacang buncis dan kacang botor tidak berbeza dan spesies ini tersebar sama rata antara strata yang berbeza pada tumbuhan kekacang. Suhu dan keamatan cahaya didapati berkorelasi positif dengan kelimpahan relatif *M. usitatus*, manakala kelembapan relatif menunjukkan hubungan yang negatif. *M. usitatus* dijumpai dalam jumlah yang banyak semasa musim panas dan kering tetapi sebaliknya pada musim hujan. Kajian ini menunjukkan bahawa musim hujan berfungsi membantu untuk mengawal atur populasi *M. usitatus* pada tumbuhan kekacang.

**Kata kunci:** Ekologi; jengking daun; kekacang; kepelbagaian; *Megalurothrips usitatus*

### INTRODUCTION

Thrips (Insecta: Thysanoptera) are small insects (>1 mm) that commonly infest crops and flowers (Palmer 1987). Despite their small size, thrips infestations can cause 80–100% losses in legume crops, particularly from the genus of *Megalurothrips* (Oparaeke 2006). Thrips damage on flower buds usually leaves behind distorted, malformed and discoloured flowers that affect pod development and eventually cause crop failure (Ogah 2011). In Malaysia, legumes, especially long beans are the most popular

vegetable planted (3,663 ha), producing approximately 42,623 metric tonnes of bean in 2011 (Anon. 2012).

Knowledge of the population density, spatial and temporal distribution of thrips on plants is critical for formulating an effective thrips management strategy (Aliakbarpour & Che Salmah 2011, 2012; Ananthkrishnan et al. 1982; Kasina et al. 2009). Checklists on thrips in Peninsular Malaysia recorded 86 known Thripidae species, including 17, 6 and 57 species from subfamilies Panchaetothripinae, Sericothripinae and Thripinae,

respectively (Azidah 2011; Mound & Azidah 2009; Ng & Mound 2015). Information on ecology and population dynamics of thrips, particularly *Megalurothrips* in relation to legume crops is scarce. According to Palmer (1987) *Megalurothrips* are commonly recorded on legumes, although the adults can be found on flowers of many other plant species (Azidah 2011; Fauziah & Wan 2004; Palmer 1987).

The aimed of this study were to determine thrips diversity on selected legumes from multiple sites in Peninsular Malaysia; to investigate the spatial and temporal distribution and abundance of *M. usitatus* on long bean, French bean and winged bean; and to elucidate the relationship between abiotic factors such as temperature, humidity and light intensity on the abundance of *M. usitatus*. The present study is important to obtain more ecological information on *M. usitatus* from legume crops which may contribute to an effective management strategy against this pest.

## METHODS

### STUDY SITE

Three agricultural farms in Peninsular Malaysia were chosen as study sites: Janda Baik (East Coast region), Bestari Jaya (Central region) and Jelebu (Southern region). All study sites do not practice insecticide spraying on crops. Geographically, Janda Baik is located at 3°21'33.1"N 101°48'29.5"E with a maximum daytime temperature of 28°C. It is surrounded with untouched natural tropical forest at altitude of 600 to 800 m above sea level. Bestari Jaya is located at 3°23'03.2"N 101°25'20.3"E with a daytime temperature that may reach 32°C. Jelebu is located at 3°04'35.1"N 101°52'46.5"E. It is the driest location in Peninsular Malaysia and receives the least amount of rainfall in a year with a daytime temperature that may reach 34°C. Like Janda Baik, Jelebu is also surrounded by hills covered by tropical forest (Jelebu 2015). Sampling was conducted from April, 2013 until May, 2014. To reduce temporal variation, sampling was done between 0800 and 1100 h. Three different species of legumes were selected for this study. They are long bean (*Vigna unguiculata*), French bean (*Phaseolus vulgaris*) and winged bean (*Psophocarpus tetragonolobus*).

### SAMPLING STRATEGY AND EXPERIMENTAL DESIGN

In Janda Baik, samples were collected from all three legumes species. While in Bestari Jaya and Jelebu, the sampling was only conducted on long bean. According to Duke (1983), French bean is not cultivated in warm regions unlike long beans which is more tolerate to high temperature. Thus, long bean is widely distributed in warm and dry regions. Khan (1982) also reported that winged bean is not tolerated to excessive high growing temperatures. For this reason, farmers do not plant French bean and winged bean in Jelebu and Bestari Jaya. Due

to availability of legumes throughout the year, monthly sampling was conducted 12 times in Janda Baik. Of these 12 months, we sampled seven times on winged bean, two times on long bean and three times on French bean. By contrast, in Bestari Jaya and Jelebu, monthly sampling was conducted for six times on long bean. The abiotic factors of temperature, relative humidity and light intensity were recorded at every sampling in Janda Baik by using whirling hygrometer (Casella London) and lux meter (Extech Instruments), respectively.

At each study site, five plots measuring 10 × 10 m were constructed. In each plot, five legume plants were randomly chosen and each plant was divided into three strata: above, middle and lower. Each stratum was approximately 0.5 m. Five flowers from each stratum were then randomly sampled for thrips. Thrips were collected by beating the legume flowers over a plastic tray. Individuals that fell on the tray were then removed with a fine brush into collecting vials containing 95% alcohol. The collected thrips were slide-mounted (Mound 2007) and were identified to species level using both the Lucid identification key from the Oz Thrips website (Mound et al. 2015) and the key in Palmer (1987) (Table 1). In addition, any foreign plant occurring in or near the plot also was recorded. For example, chillies and durian trees, especially in Janda Baik, were planted among legume crops and can act as alternate plants.

### DATA ANALYSES

Shannon and Simpson's diversity indices and Shannon's evenness index were calculated for each site STATISTICA (Statsoft Inc 2001). One-way ANOVA was used to determine if there was a significant difference in the mean abundance of *M. usitatus* among different study sites and different legume plant strata followed by Tukey's test ( $p=0.05$ ). Correlations between the abundance of male and female of *M. usitatus* and the different abiotic factors (temperature, light intensity and relative humidity) in Janda Baik were assessed. One-way ANOVA was also used to determine if the abundance of male and female of *M. usitatus* varied among different species of legumes (long bean, winged bean and French bean). All analyses were conducted using STATISTICA (StatSoft Inc 2001).

## RESULTS

### THRIPS DIVERSITY AND ABUNDANCE

There were three genera of thrips that were found on the legume hosts, namely *Megalurothrips* (*M. usitatus*), *Thrips* (*T. hawaiiensis* and *T. parvispinus*) and *Ceratothripoides* (*C. brunneus*). *M. usitatus* had the highest mean abundance at each site, followed by *T. parvispinus* (Table 1). In contrast, *T. hawaiiensis*, which was found in low numbers in all sites and *C. brunneus* which was found only in Janda Baik, were the two thrips species found least frequently on the legumes (Table 1). Overall, in Janda Baik, 64% of the collected thrips species were *Megalurothrips* species,

TABLE 1. Mean number of thrips species on three different species of legumes flowers; long bean, French bean and winged bean, at three different selected agricultural farms from April 2013 until May 2014

Thrips species	Janda Baik	Bestari Jaya	Jelebu
<i>Megalurothrips usitatus</i>	23.83 ± 14.73	171.57±88.01	163.73±125.85
<i>Thrips parvispinus</i>	21.68 ± 20.11	11.56 ± 9.74	10.01 ± 8.67
<i>Ceratothripoides brunneus</i>	0.85 ± 0.43	0	0
<i>Thrips hawaiiensis</i>	0.94 ± 0.53	0.53 ± 0.31	0.1 ± 0.00

whereas in both Bestari Jaya and Jelebu, 95% of collected thrips were *Megalurothrips*.

There was a significant difference in overall abundance of *M. usitatus* at the different sites ( $F = 9.6$ ,  $df = 2, 88$ ,  $p < 0.05$ ), with Bestari Jaya having the most females ( $141 \pm 72.3$ ) and males ( $30.6 \pm 25.9$ ), while Janda Baik having the fewest females ( $41.9 \pm 27.5$ ) and males ( $1.5 \pm 2.3$ ) (Figure 1). Janda Baik had the highest Shannon and Simpson diversity compared to Bestari Jaya and Jelebu (Table 2). This is due to the high proportion and dominance of *M. usitatus* at both Bestari Jaya and Jelebu.

#### SPATIAL AND TEMPORAL DISTRIBUTION

There was no significant difference in the distribution of *M. usitatus* at the three different strata in the legume plants (Table 3). However, there were significant differences between the number of females ( $F = 15.7$ ,  $df = 11, 48$ ,  $p < 0.05$ ) and males ( $F = 7.389$ ,  $df = 11, 48$ ,  $p < 0.05$ ) of *M.*

*usitatus* among different months. The number of females was highest in January and February ( $110.6 \pm 40.8$  and  $111.4 \pm 39.0$ ), with a temperature of 27°C and 29°C and lowest in December ( $1 \pm 1$ ), where the temperature was 24°C (Figure 2). Similarly, the abundance of males was highest in January and February ( $9.8 \pm 3.5$  and  $7.8 \pm 10.0$ ) but lowest in March, July, August and December, where no male specimen was collected at an average temperature of 25°C (Figure 2).

#### CORRELATION BETWEEN *M. USITATUS* POPULATIONS AND ABIOTIC FACTORS

There was a moderate correlation between the female abundance and temperature ( $r = 0.63$ ,  $p < 0.05$ ) (Figure 3(a)), but a strong correlation between the total number of males and temperature ( $r = 0.75$ ,  $p < 0.05$ ) (Figure 3(b)). Thus, temperature appears to influence the total number of both females and males of *M. usitatus*.

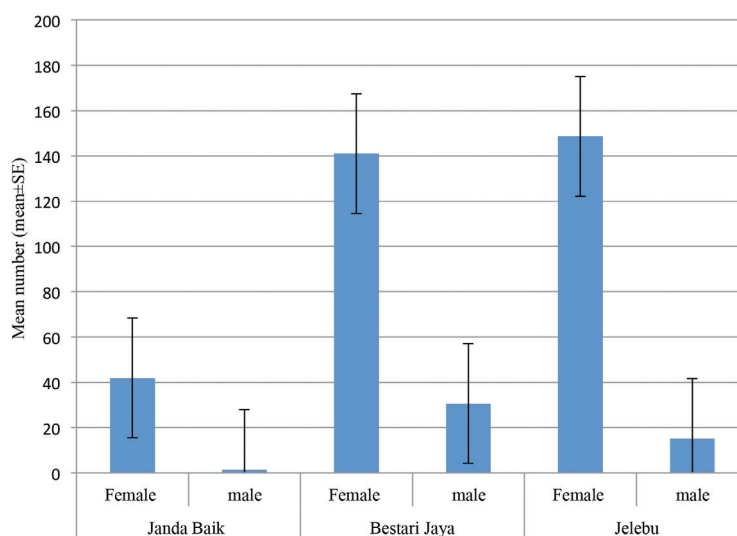


FIGURE 1. Mean numbers of females and males of *Megalurothrips usitatus* sampled on legumes from three selected agricultural farms of different regions in Peninsular Malaysia (April 2013 to May 2014)

TABLE 2. Thrips species diversity indices on three different species of legumes flowers; long bean, French bean and winged bean at three different selected agricultural farms from April 2013 until May 2014

	Janda Baik	Bestari Jaya	Jelebu
Evenness $e^{H_s}$	0.5142	0.6139	0.3056
Shannon H	0.7211	0.2052	0.2009
Simpson 1-D	0.4701	0.0991	0.0932

TABLE 3. Relative abundance of *M. usitatus* at three different stratum of legume plants at three different selected agricultural farms from April 2013 until May 2014

Location	stratum	n	Mean	p-value
Janda Baik	Above	6	98.5±68.1	> 0.05
	Middle	6	65.8±40.2	
	Lower	6	64.8±32.9	
Bestari Jaya	Above	6	355.0±174.4	> 0.05
	Middle	6	293.0±154.5	
	Lower	6	209.8±81.1	
Jelebu	Above	6	384.2±191.4	> 0.05
	Middle	6	253.0±150.0	
	Lower	6	180.0±177.6	

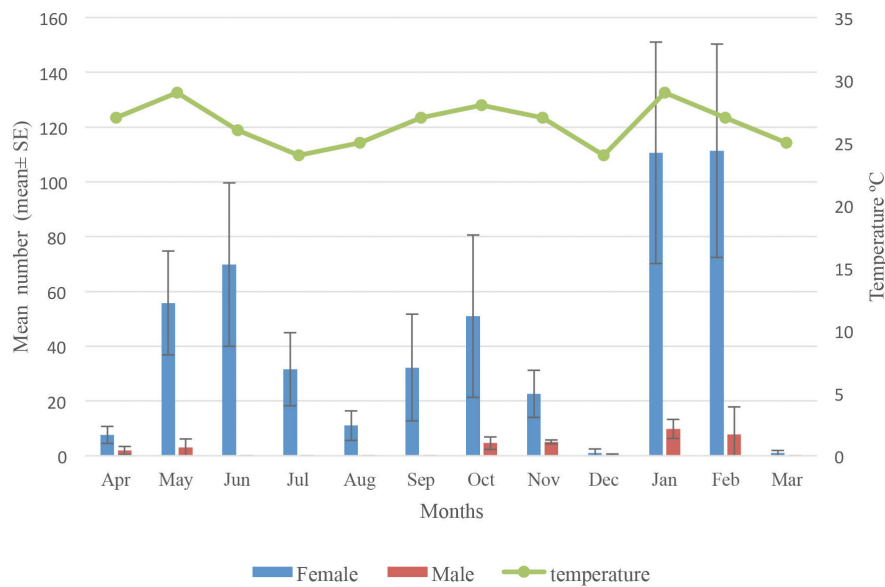


FIGURE 2. Mean numbers of females and males of *Megalurothrips usitatus* in Janda Baik in relation to temperature from April 2013 until May 2014

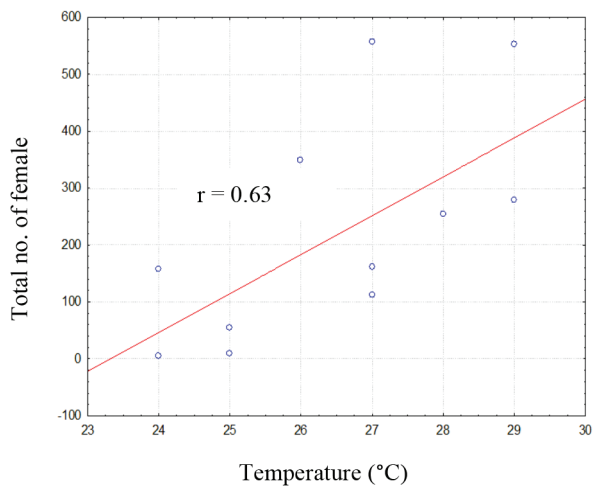


FIGURE 3a. Correlation between the total number of female of *Megalurothrips usitatus* in Janda Baik and the temperature from April 2013 to May 2014

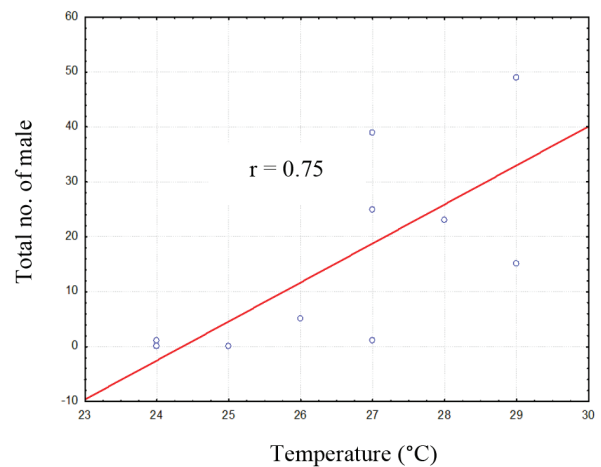


FIGURE 3b. Correlation between total numbers of male of *Megalurothrips usitatus* in Janda Baik and the temperature from April 2013 to May 2014

Relative humidity in Janda Baik fluctuated between 79% and 100%, with an average of 88.17%. There was a weak negative correlation between both the total number of females ( $r = -0.07, p < 0.05$ ) (Figure 3(c)) and males ( $r = -0.34, p < 0.05$ ) (Figure 3(d)) with relative humidity. Light intensity also fluctuated in Janda Baik, ranging from 18 to 70 × kcd. Light intensity was moderately correlated with the total number of females ( $r = 0.5, p < 0.05$ ) (Figure 3(e)), but weakly correlated with the total number of males ( $r = 0.4, p < 0.05$ ) (Figure 3(f)). Hence, the light intensity may also have influenced the total number of both females and males of *M. usitatus*.

#### POPULATION OF *M. USITATUS* ON DIFFERENT LEGUME SPECIES

There was no significant difference in the total number of female ( $F = 27.67, df = 2, 57, p > 0.05$ ) or male ( $F = 8.67, df = 2, 57, p > 0.05$ ) of *M. usitatus* on different legume species, i.e., *T. teragonolobus*, *P. vulgaris* and *V. unguiculata*.

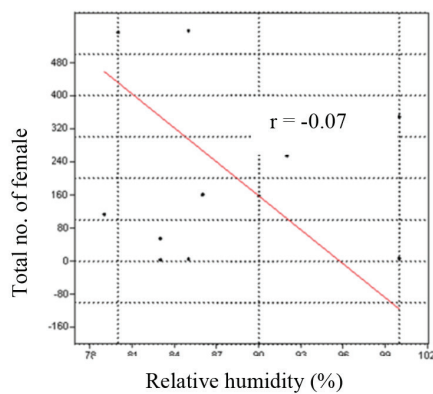


FIGURE 3c. Correlation between numbers of female of *Megalurothrips usitatus* in Janda Baik and the relative humidity from April 2013 to May 2014

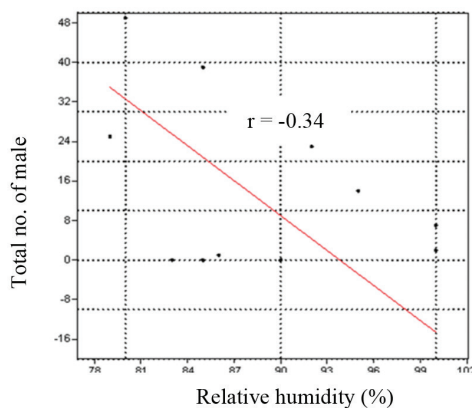


FIGURE 3d. Correlation between total numbers of male of *Megalurothrips usitatus* in Janda Baik and the relative humidity from April 2013 to May 2014

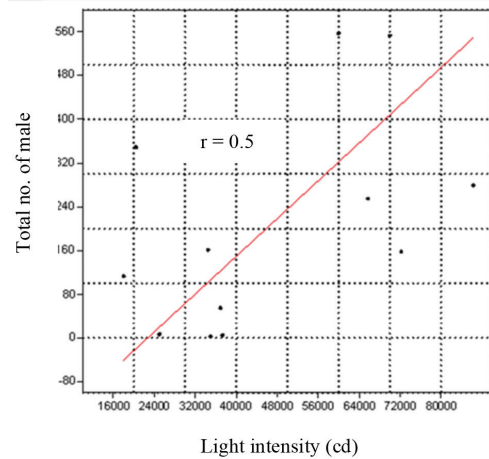


FIGURE 3e. Correlation between total numbers of female of *Megalurothrips usitatus* in Janda Baik and the light intensity from April 2013 to May 2014

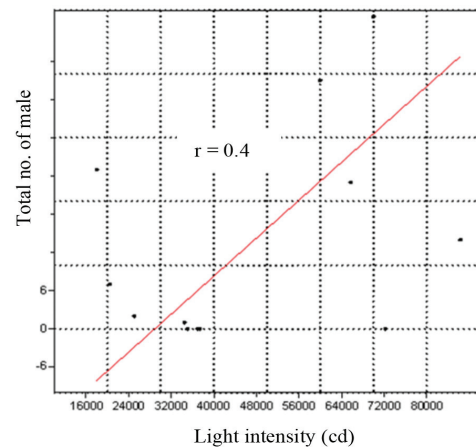


FIGURE 3f. Correlation between total numbers of male of *Megalurothrips usitatus* in Janda Baik and the light intensity from April 2013 to May 2014

#### DISCUSSION

We detected a difference in the total number of *M. usitatus* between the study sites in Janda Baik and Bestari Jaya. This occurrence was probably due to differences in the altitudinal level and the total amount of rainfall between the study sites. In this case, Janda Baik, with lowest thrips population, is located at the highest altitude (about 600-800 m above sea level), possessing the lowest average daily temperature at peak (28°C) and the highest total amount of rainfall (2500-3500 mm per year) (Iklim Malaysia 2015). By contrast, Bestari Jaya, with highest thrips population, is located at a lower altitude (about 7-17 m above sea level), has higher average temperature (32°C) and a lower total amount of rainfall (2000-2500 mm per year) (Taburan hujan 2015). According to Waiganjo et al. (2008), different climate trends and varied weather patterns may affect *M. usitatus* populations. This is supported by Lorini and Junior (1990) who stated that high temperature and lack of rainfall

have increased thrips populations, while heavy rain with lower temperature has caused sharp declines.

This study showed that *M. usitatus* was distributed equally among the different strata of the legume plants. According to Pickett et al. (1988), thrips prefer younger flowers that are usually located at the upper stratum. This is due to food availability, such as floral nectar and pollen that represents an additional food source for the adult thrips. On the other hand, the older flowers, which usually are located at the lower strata of the plant, typically already have shed their pollen and have fewer resources (Kasina et al. 2009). However, in this study, food is not the only resource for thrips on legumes. Based on our observations, younger flowers are smaller in size and offer less space for protection, but older flowers have bigger space that provide protection for thrips against predators. Thus, the equal distribution of *M. usitatus* found among strata in the legumes sampled in this study may be a consequence of both protection and food resources.

The results also showed that *M. usitatus* was present throughout the study period even though the numbers are fluctuated. The total number of females and males of *M. usitatus* were highest in the months of January and February, but lowest in December. This may be due to differences in weather conditions, with the hot season in January and February but a heavy rainy season that included the months of December, March, July and August, where no male specimens were collected at all. Ananthakrishnan (1990) also indicated that the number and density of thrips fluctuated between months in relation to their life histories and environmental factors, such as precipitation, humidity and temperature. Lewis (1973) reported that reproduction and survival of most species of thrips often encouraged by a warm, sunny and dry climate, but when rainfall is heavy, populations decline drastically. This phenomenon is supported by Harrison (1963) and Ibrahim and Adesiyun (2010) who found that rain with hail washed away an entire population of *T. tabaci* from onion crop. Furthermore, when the larvae burrowed into the ground, heavy rains would drown and wash away the crevices in the soil.

The presence of *T. parvispinus* in this study may be due to the other host plants planted between the legumes, such as chilli, especially in Janda Baik. *T. parvispinus*, *T. hawaiiensis* and *C. brunneus* were reported to be pests of chilli (Azidah 2011; Johari et al. 2014). There is a possibility that these thrips might fly from their host and land on legumes. According to Aliteri (1986), this phenomenon could be happened due to the difficulty and misallocation of the real host by thrips especially for feeding and breeding as the odours released by some plants might mask the effect of those released by other plants.

In general, light intensity increase thrips activity (Johansen et al. 2011; Lewis 1973). According to Kirk (1996), high light intensity affects thrips flying and feeding activities. Our study showed that abundances of both female and male of *M. usitatus* were correlated positively with light intensity but negatively against relative humidity.

## CONCLUSION

*Megalurothrips usitatus* is the most common thrips species on legumes at Janda Baik, Jelevu and Bestari Jaya, apart from *T. hawaiiensis*, *T. parvispinus* and *C. brunneus*. Thrips diversity and abundance were found to be affected by the cropping systems with *M. usitatus* equally distributed among different strata of the legume plant. *M. usitatus* was present throughout the year and was found abundantly at low altitudinal areas during the dry season. We further showed that *M. usitatus* population was correlated positively with abiotic factors such as temperature and light intensity but not to relative humidity.

## ACKNOWLEDGEMENTS

We would like to thank Mr. NorSam, Mr. Zainal, Mr. Tong, Mrs. Habibah and Mrs. Wahida, the owners of the legume plantations for permission of insect sampling. Appreciation also due to Institute of Biological Sciences, University of Malaya for research grant (RG06-909SUS) and Museum of Zoology for the facilities provided.

## REFERENCES

- Aliakbarpour, H. & Che Salmah, M.R. 2011. Seasonal abundance and spatial distribution of larval and adult thrips (Thysanoptera) on weed host plants in mango orchards in Penang, Malaysia. *Applied Entomology and Zoology* 46: 185-194.
- Aliakbarpour, H. & Che Salamah, M.R. 2012. The species composition of thrips (Insecta: Thysanoptera) Inhibiting Mango Orchards in Pulau Pinang, Malaysia. *Tropical Life Sciences Research* 23(1): 45-61.
- Aliteri, M.A. 1986. The dynamics of colonizing arthropod communities at interface of abandoned, organic and commercial apple orchards and adjacent wood-land habitats. *Agriculture, Ecosystem and Environment* 16: 29-43.
- Ananthakrishnan, T.N. 1990. *Reproductive of Biology Thrips*. Indira Publishing House. p. 34.
- Ananthakrishnan, T.N., Raman, K. & Sanjayan, K.P. 1982. Comparative growth rate, fecundity and oral diversity of the dusky cotton bug, *Oxycarenus hyalinipennis* (Costa) (Hemiptera; Lygaeidae) on certain malvaceous host plants, *Proceeding of the National Academy of Sciences, India* 48: 577-584.
- Anon. 2012. *Vegetable and Cash Crops Statistics Malaysia*. Peninsular Malaysia, Jabatan Pertanian Semenanjung Malaysia.
- Azidah, A.A. 2011. Thripidae (Thysanoptera) species collected from common plants and crops in peninsular Malaysia. *Scientific Research and Essays* 6(24): 5107-5113.
- Duke, J.A. 1983. *Handbook of Energy Crops*. NewCROPS web site, Purdue University. [http://www.hort.purdue.edu/newcrop/duke\\_energy/dukeindexhtml](http://www.hort.purdue.edu/newcrop/duke_energy/dukeindexhtml). Accessed on 29 April 2016.
- Fauziah, I. & Wan, M.A.K. 2004. *Diversity and Systematics of Thrips Species on Legumes*. Laporan akhir penyelidikan UITM 10283.
- Harrison, J.O. 1963. Notes on the biology of the banana flower thrips *Frankliniella parvula*, in the Dominican Republic. *Annals of the Entomological Society of America* 56: 664-666.

- Ibrahim, N.D. & Adesiyun, A.A. 2010. Effects of transplanting dates and insecticides frequency in the control of *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) on Onion (*Allium cepa* L.) in Sokoto, Nigeria. *Journal of Agriculture Science* 2(2): 239-249.
- Iklim Malaysia. 2015. In Laman Web Rasmi Jabatan Meteorologi Malaysia (MetMalaysia). <http://www.met.gov.my/web/metmalaysia/climate/generalinformation/malaysia>. Accessed on 2 February 2016.
- Jelebu 2015. Portal Rasmi Daerah Jelebu. <http://www.mdjelebu.gov.my/web/guest/home>. Accessed on 27 December 2014.
- Johansen, N.S., Eriksen, A.S. & Mortensen, L. 2011. Light quality influences trap catches of *Frankliniella occidentalis* (Pergande) and *Trialetrodes vorporariorum* (Westwood). *Integrated Control in Protected Crops, Temperate Climate IOBC/wprs Bulletin* 68: 89-92.
- Johari, A., Herlinda, S., Pujiastuti, Y., Irsan, C. & Sartiami, D. 2014. Morphological and genetic variation of *Thrips parvispinus* (Thysanoptera: Thripidae) in chili plantation (*Capsicum annum* L.) in the lowland and highland of Jambi Province, Indonesia. *American Journal of Bioscience* 2(6-1): 17-21.
- Kasina, M., Nderitu, J., Nyamasyo, G., Waturu, C., Olubayo, F., Obudho, E. & Yobera, D. 2009. Within plant distribution and seasonal population dynamics of Flower Thrips (Thysanoptera: Thripidae) infesting French Beans (*Phaseolus vulgaris* L.) in Kenya. *Spanish Journal of Agricultural Research* 7(3): 625-659.
- Khan, T.N. 1982. *Winged Bean Production in the Tropics*. Rome: FAO. p. 217.
- Kirk, W.D.J. 1996. *Thrips Naturalists' Handbooks*. Slough, The Richmond Publishing Company Limited.
- Lewis, T. 1973. *Thrips: Their Biology, Ecology and Economics Importance*. England: Academic Press London and New York.
- Lorini, I. & Junior, V. M. 1990. Population fluctuations of *Thrips tabaci* Lindeman, (Thysanoptera: Thripidae) on garlic crop. *Anais da Sociedade Entomologica do Brasil* 19(2): 367-371.
- Mound, L.A. 2007. *Thysanoptera biology and identification: technique for preparing micro-slides used at Canberra for thrips*. Canberra: Commonwealth Scientific and Industrial Research Organization Entomology, Australia.
- Mound, L.A. & Azidah, A.A. 2009. Species of the genus *Thrips* (Thysanoptera) from Peninsular Malaysia, with a checklist of recorded Thripidae. *Zootaxa* 2023: 55-68.
- Mound, L.A. & Collins, D.W. 2000. A south East Asian pest species newly recorded from Europe: *Thrips parvispinus* (Thysanoptera: Thripidae), its confused identity and potential quarantine significance. *Journal of European Entomology* 97: 197-200.
- Mound, L.A., Tree, D.J. & Paris, D. 2015. *OZ THRIPS, Thysanoptera in Australia*. <http://www.ozthrips.org/>. Accessed on 27 December 2014.
- Ng, Y.F. & Mound L.A. 2015. Species of Thripinae (Thysanoptera) from bamboo in Malaysia, with one new species and six new records. *Zootaxa* 3918(4): 492-502.
- Ogah, E.O. 2011. Assessing the impact of varietal resistance and planting dates on the incidence of African Yam Bean Flower Thrips (*Megalurothrips sjostedti*, Hochst.Ex. A. Rich) in Nigeria. *Asian Journal Plant Sciences* 10(7): 370-375.
- Oparaeke, A.M. 2006. The sensitivity of flower bud thrips, *Megalurothrips sjodjesti* Trybom (Thysanoptera: Thripidae), on cowpea to three Concentrations and Spraying Schedules of *Piper guineense* Schum. & Thonn. Extracts. *Journal of Plant Protection Science* 42(3): 106-111.
- Palmer, J.M. 1987. *Megalurothrips* in the flowers of tropical legumes: a morphometric study. In *Population Structure, Genetics and Taxonomy of Aphids and Thysanoptera*, edited by Holman, J., Pelikan, J., Dixon, A.F.G. & Weismann, L. The Hague: SPB Academic Publishing. pp. 480-495.
- Pickett, C.H., Wilson, L.T. & Gonzalez, D. 1988. Population dynamics and within-plant distribution of the Western Flower Thrips (Thysanoptera: Thripidae), an early season predator of spider mites infesting cotton. *Entomological Society of America* 17(3): 551-559.
- StatSoft Inc. 2001. Electronic statistics textbook. <http://www.statsoft.com/textbook/stathome.html>. Accessed on 27 December 2014.
- Taburan hujan Malaysia 2015. Laman Web Rasmi Jabatan Meteorologi Malaysia (MetMalaysia). <http://www.met.gov.my/web/metmalaysia/observations/surface/dailyrainfall>. Accessed on 27 December 2014.
- Waiganjo, M.M., Gitonga, L.M. & Mueke, J.M. 2008. Effects of weathr on onion thrips population dynamics. *African Journal of Horticultural Science* 1: 82-90.

Institute of Biological Science  
Faculty of Science  
University of Malaya  
50603 Kuala Lumpur, Wilayah Persekutuan  
Malaysia

\*Corresponding author; email: zafzakri@yahoo.com

Received: 18 April 2016

Accepted: 14 September 2017